Operational Use of Bias Corrected Ensemble Data

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OVERVIEW

- Why do we bias correct the data?
- How do we bias correct the data?
- NCEP bias correction variables
- Examples of bias corrected data

  – BOIVerify has bias corrected data!

Why bias correct the data?

To grab the low hanging fruit

- **Models have systematic errors**
  - Based on physics and parameterizations
  - Based on the larger scale pattern
- **Thus a model might**:
  - Have a cold bias in a region.
  - And a warm bias in another region.
  - There are many bias which may be present….

Identify Model Problems and correct with Bias

- Too dry or too wet
- Too cold or too warm
- Winds to strong or too weak
- Lee side troughs too strong or too weak
- To much QPF in a location too little in another
- The list is nearly endless….
  - as we all know ☺

Global Ensemble Forecast System - GEFS

- Is based on the NCEP GFS model
- Thus the GEFS members
  - Have all the bias problems inherit in the GFS system
  - The bias can be identified and mitigated
- Bias correction
  - Can improve the range of predictability
  - Gain hours to a few days more accuracy

Key Point for Operational users

- What is the Bias? Forecast (F) minus Analysis (A)

  B = F-A

- Example with 850 hPa temps

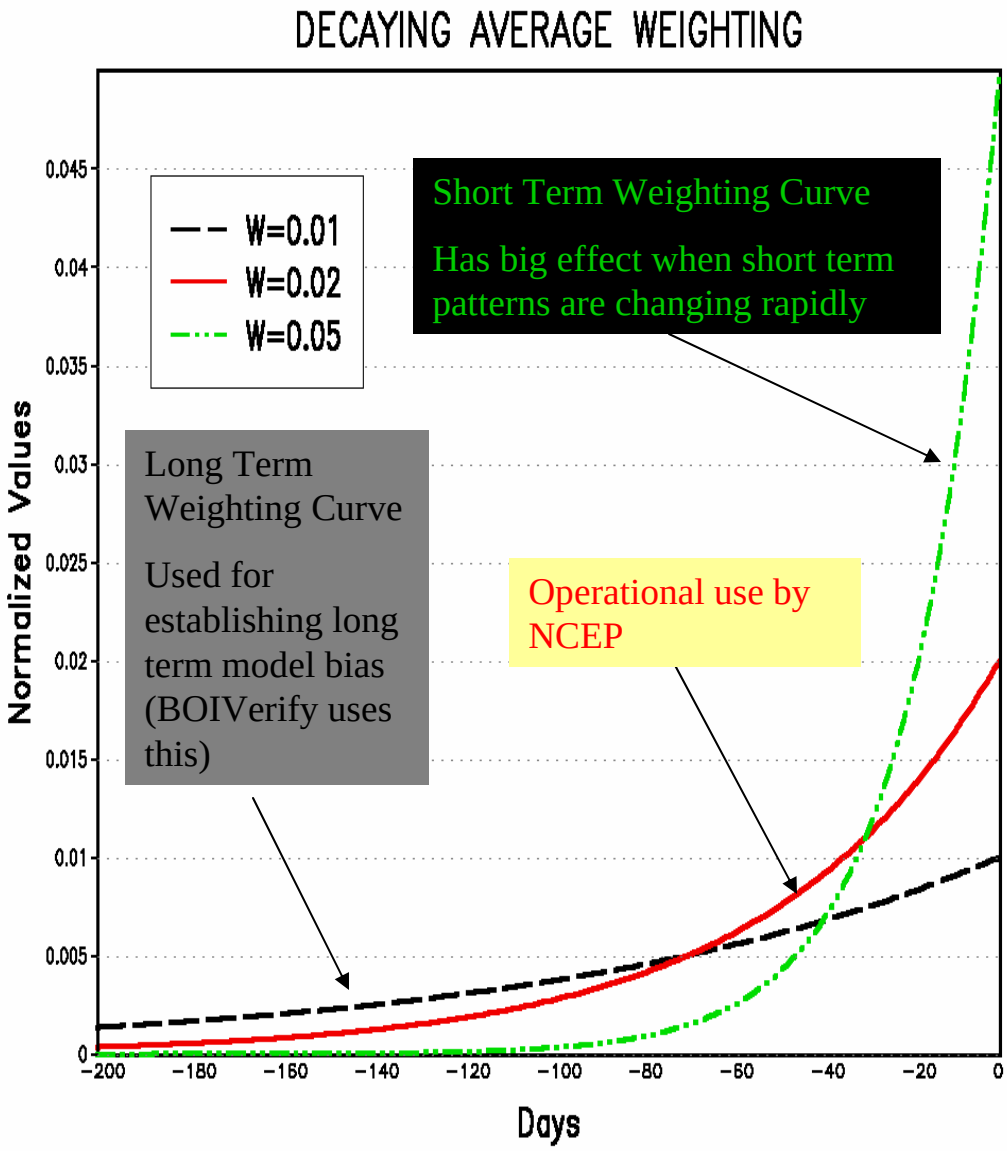
  B < 0 → F < A cold bias

  B > 0 → F > A warm bias

- Thus measurement of Bias uses simple verification techniques to improve the forecast of the EPS.

Bias Correction Method & Application

- NCEP uses an Adaptive algorithm:
- A decaying average weighting scheme is used
- Different curves represent different weights to apply to the bias.
- Related to how quickly the atmosphere is changing.
- W is the weight for the decaying average
- W equals 0.02 (2%) has been used for operations, which is approximately using 50-100 days information → ***use most recent data more heavily in process.***
- However try to keep bias from flip-flopping do to rapid changes in the short term → ***use middle curve***



Interim Summary→next topic

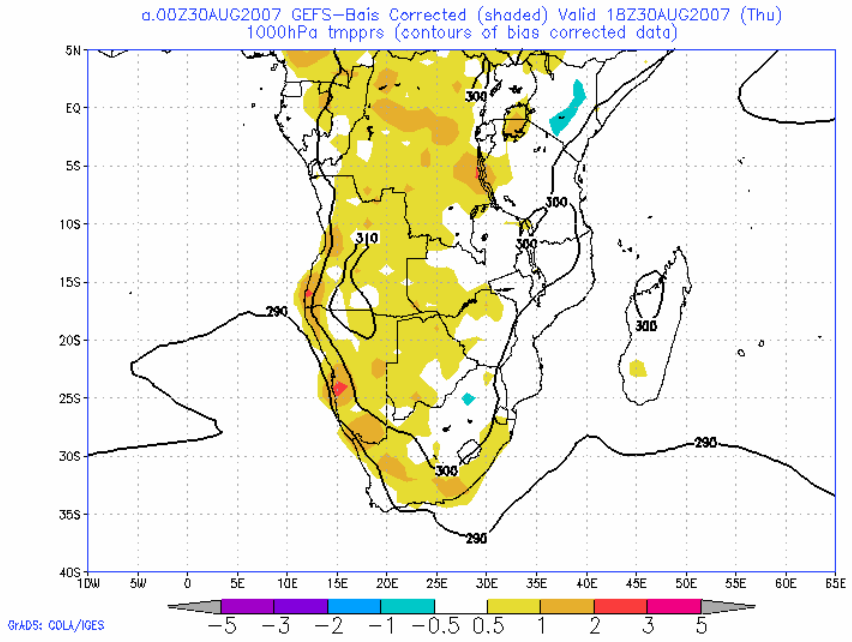
- **This is why we bias correct the models:**
  - *Remove systematic errors to extend length of skill*
  - *Remove systematic errors due to physics and parameterizations schemes*
  - *Result is lower forecast error*
- **This is how we bias correct the data:**
  - ***Use past forecasts and verification***
  - ***Based on verification….Simple F-A***
  - *It's easy to do: Grab the low hanging fruit*

Impacts of bias correction

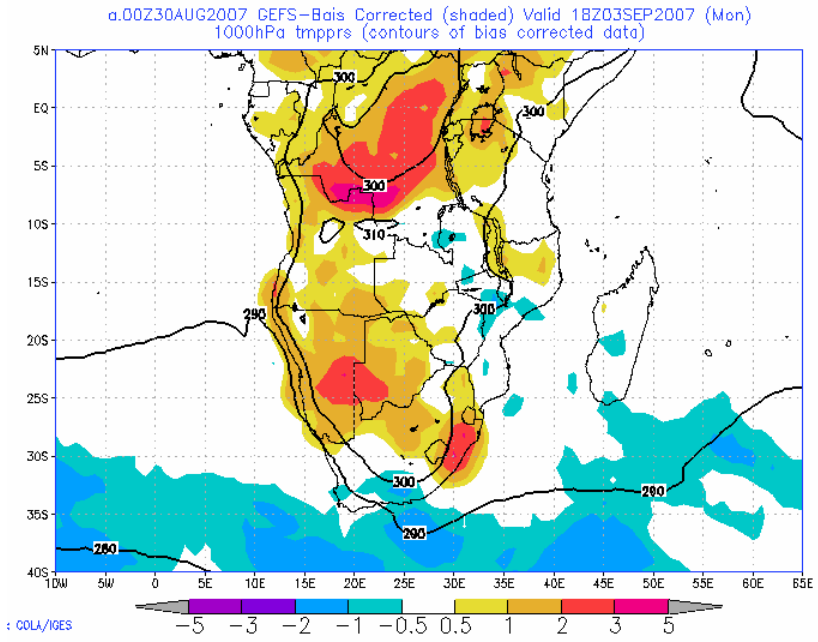
Remember this:

- Bias correction has the most impact at low levels and at longer forecast periods

Impact stronger at lower levels
1000 hPa temperatures

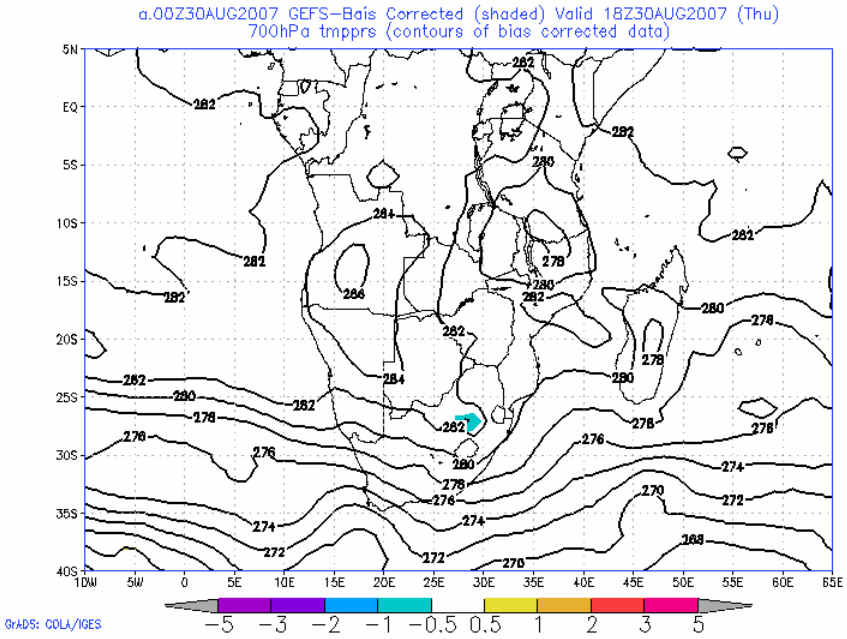


30 hour forecasts

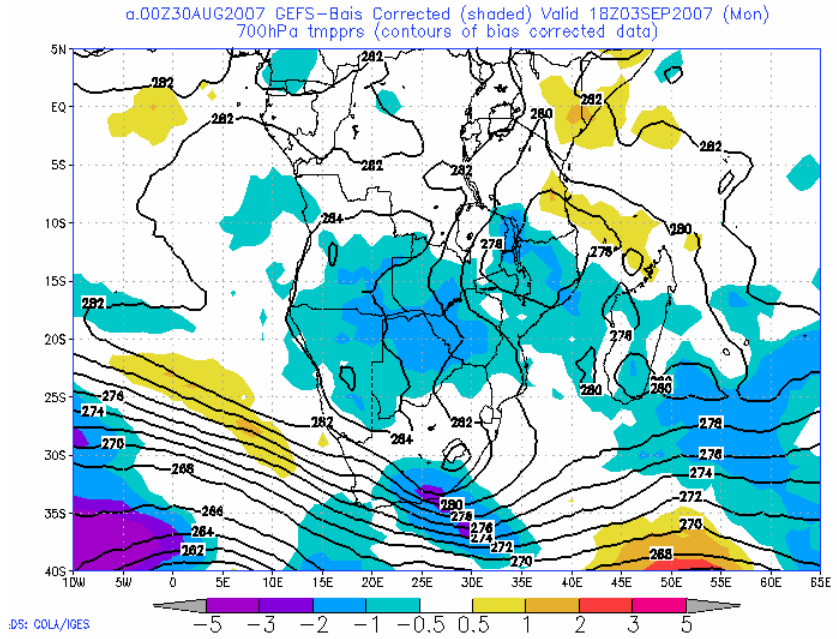


120 hour forecasts

Bias correction is insignificant at short ranges! Has impact at longer ranges. 700 hPa Temps



30 hour forecasts



120 hour forecasts

Bias Corrected Temperatures

- **Impacts of the correction is stronger at lower levels**

- **Showed 1000, 850 and 700 hPa**
  - Impact larger at longer ranges
  - 850 and 700 hPa used in K-Index and Total Totals Index computations
    - So any type of derived field would be improved via Bias correction
    - Can impact and incrementally improve products
    - 850 hPa will be more impacted than 700 hPa.

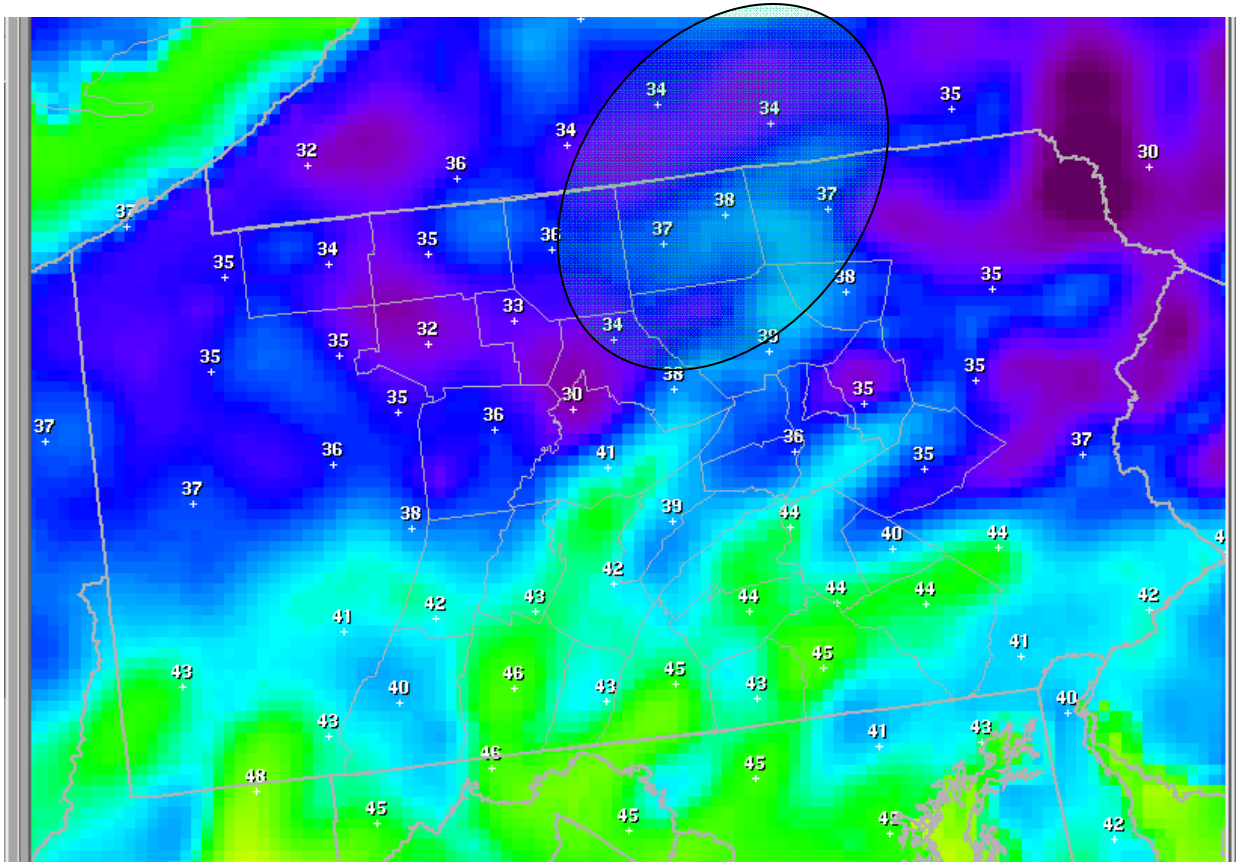
- **Thus:**
  - We see the impact of the Bias Correction technique
  - We see the ***value of verification*** in the forecast process

Value of Verification

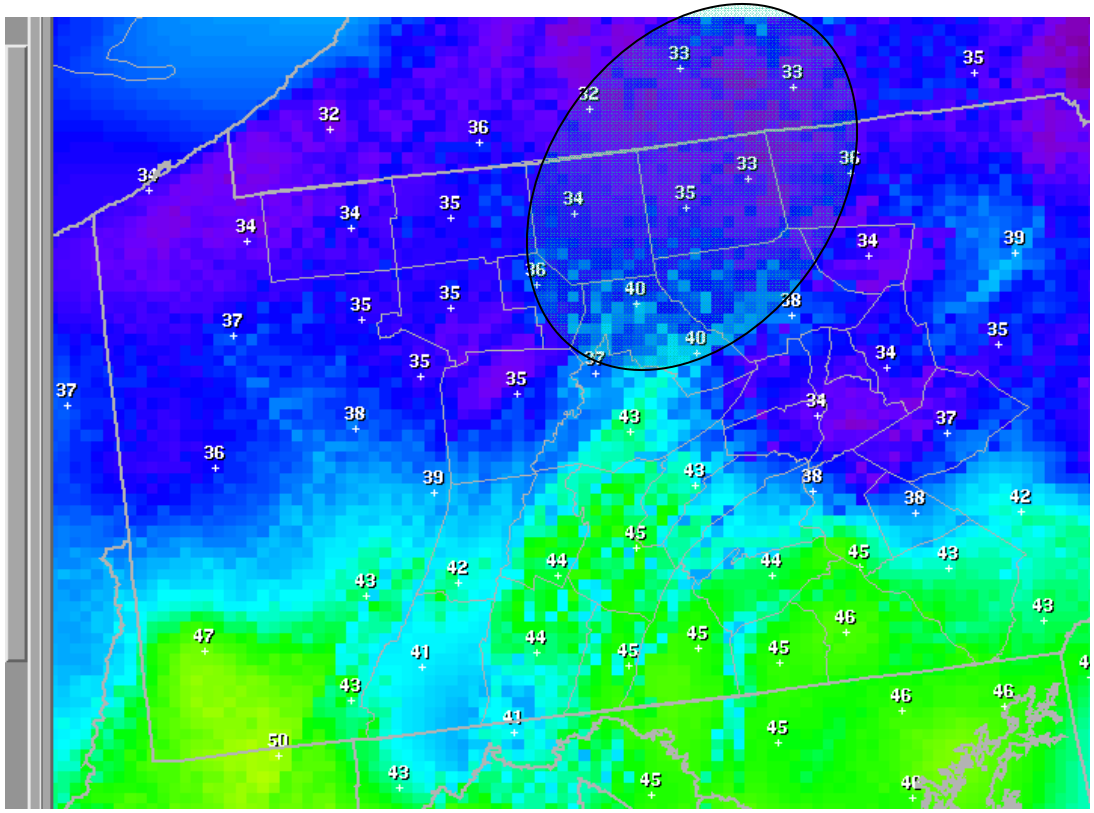
- Any verification process begins with good observational data
  - Thus it will be important to make sure observations feeding into the bias correction are correct
  - Need to have high quality control of observations
- Ex….RTMA used in BOIVerify

The RTMA “warm” Freezing Rain Event

RTMA Analysis



Adjacent Observations



Impact

- RTMA was too warm….not even close to freezing
- Freezing rain/drizzle was a problem
- Advisory issued for freezing precipitation
  - Where RTMA was not even close to 0C!

Conclusion of Warm Freezing Rain Event

The RTMA was not representative

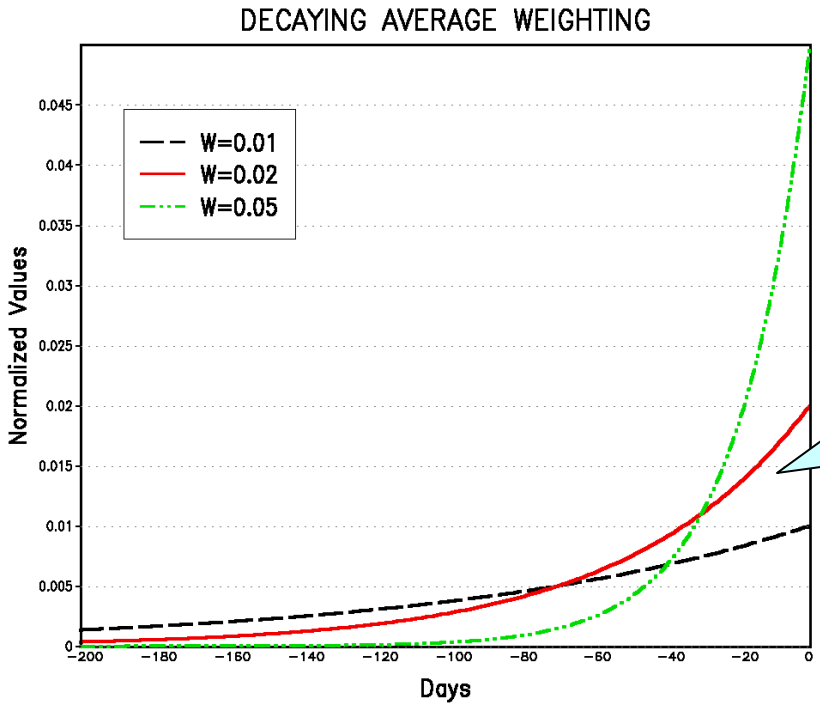
- The observations should be used in cases where the RTMA is of ***no meteorological Value.***

- If we are verifying off the RTMA we need to fix it so it is at least realistic.

Bias Corrected Data

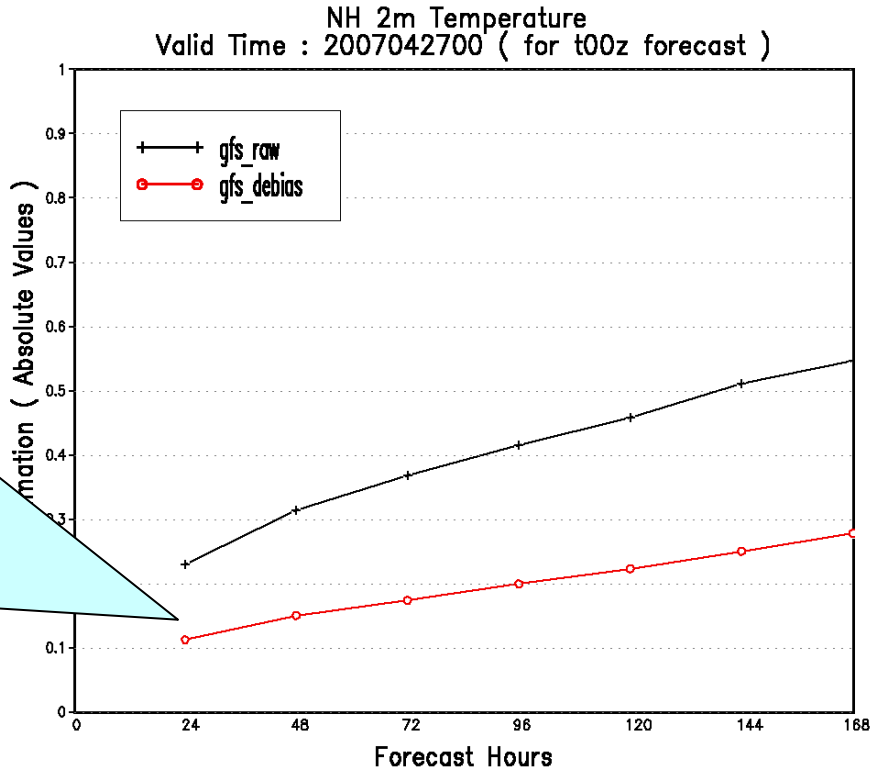
- **Some general findings:**
  - **Impacts of the bias correction is stronger at lower levels**
  - **Impacts evolve with time and show greater impacts at longer ranges**
  - **In first 6-48 hours impacts are generally quite small→ models more skillful at shorter time periods so smaller errors/bias.**

- **Some concepts**
  - ***We can and do use these data like EPS data***
  - **They should have slightly better skill most of the time at longer ranges**
  - **Bias correct fields such as 850 hPa and 700 hPa temperatures**
    - **Will impact our derived variables such as KI and TTI**
- **These data should help**
  - In the 3-7 day range
  - With several critical variables available



GFS bias correction based on an accumulated bias by using decaying average weight (0.02) which is the same as GEFS used

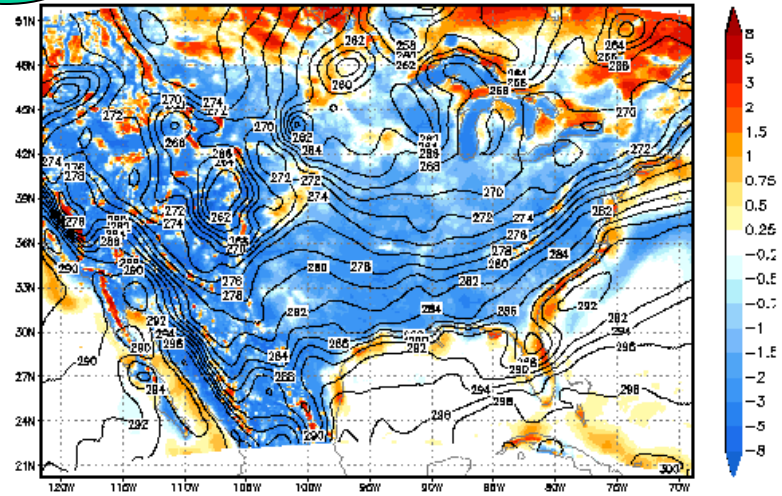
The absolute errors are reduced after bias correction for 2-meter temperature (The stats are accumulated from 0.02 decaying average)



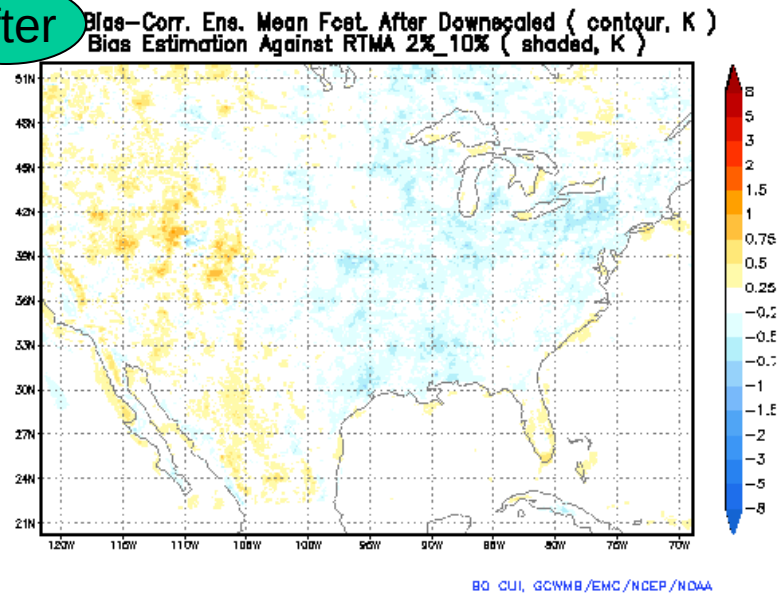
00hr GEFS Ensemble Mean & Bias Before/After Downscaling 10%

2m Temperature

Before

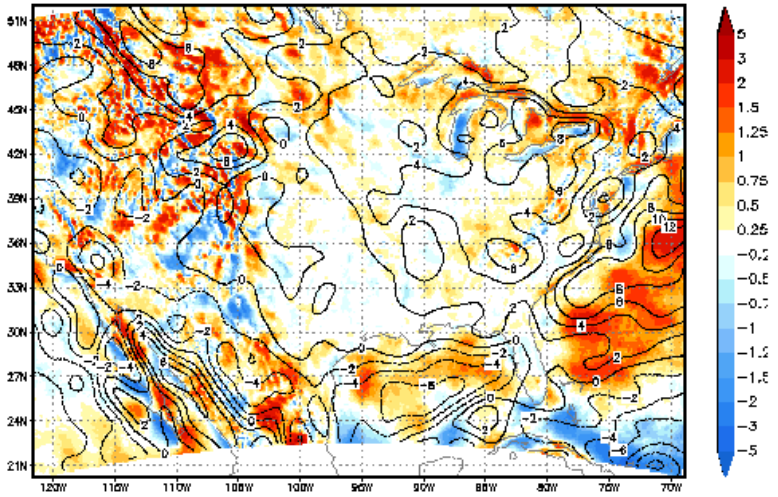


After

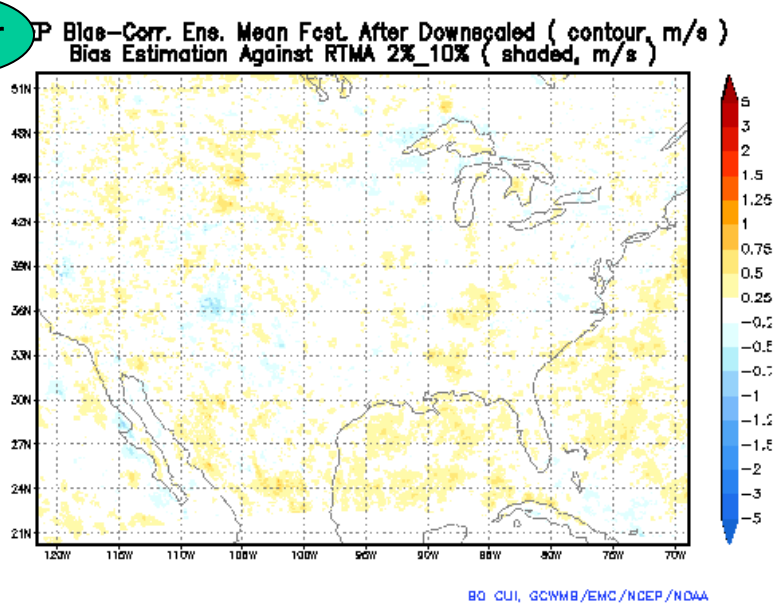


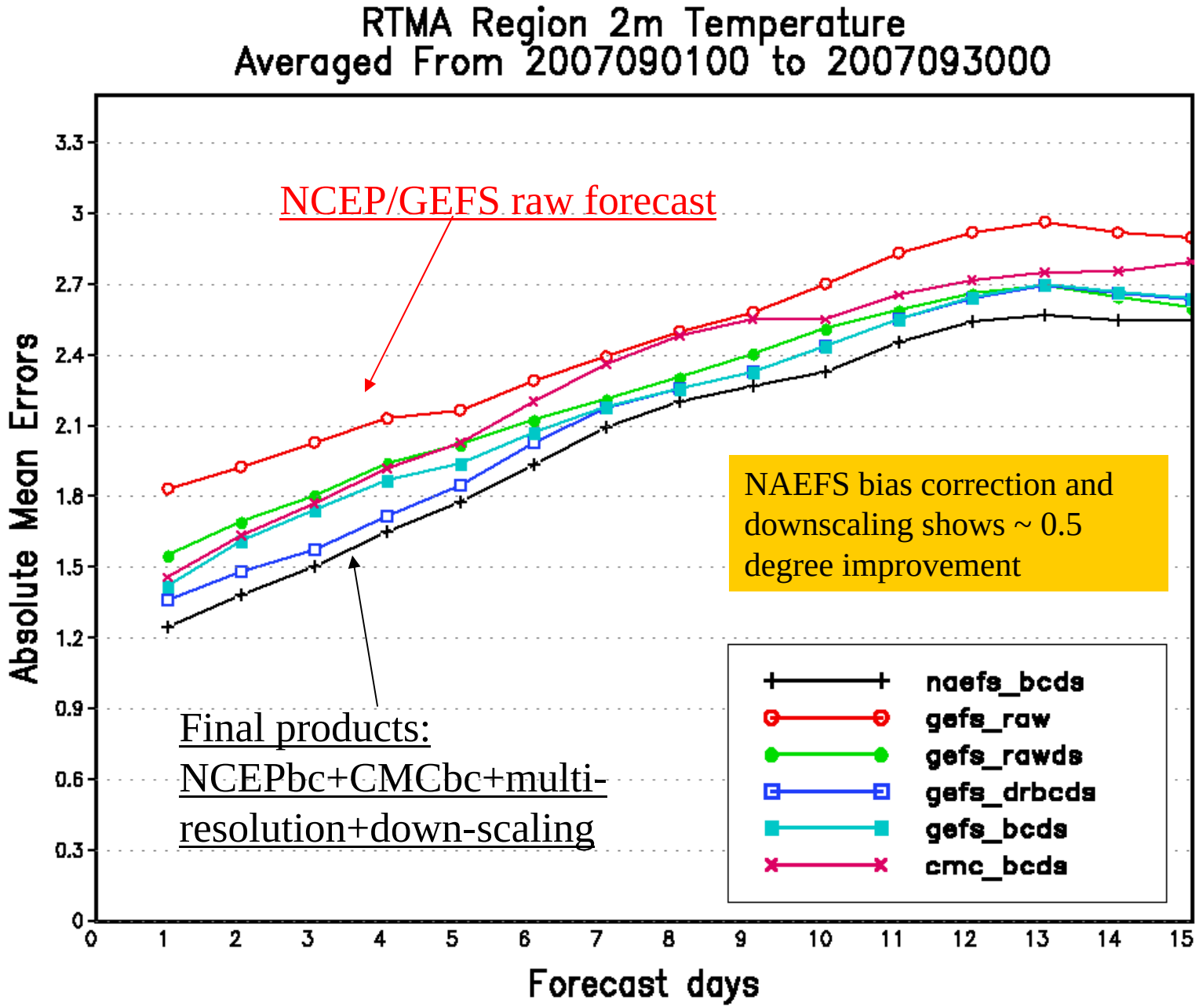
10m U Wind

Before

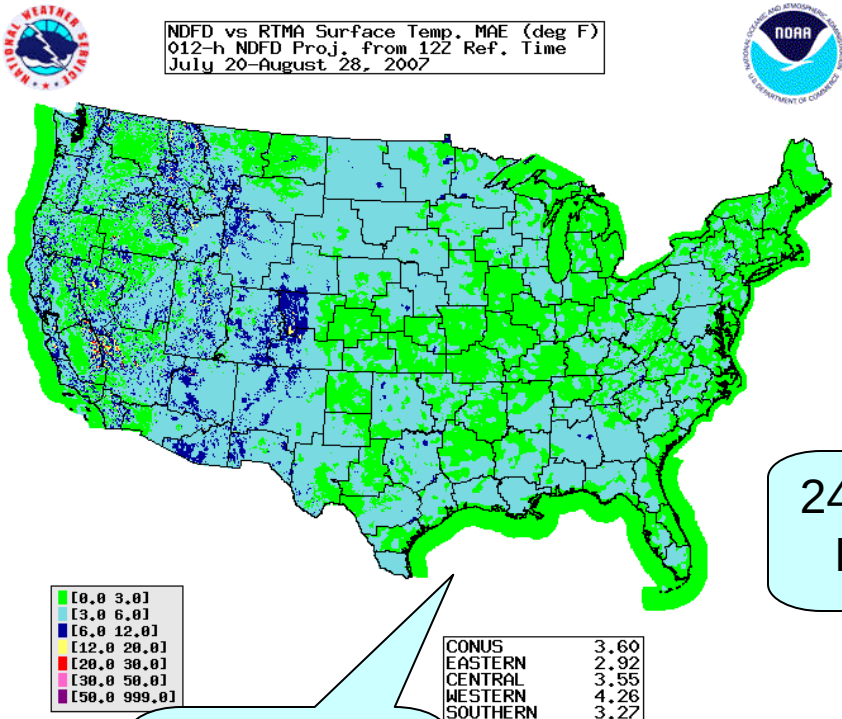


After

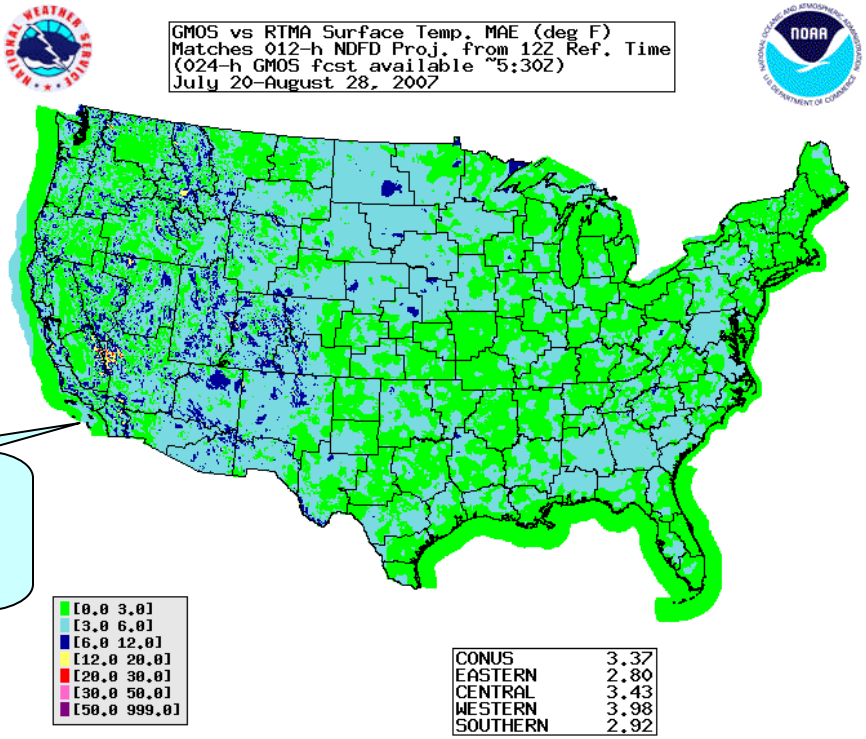




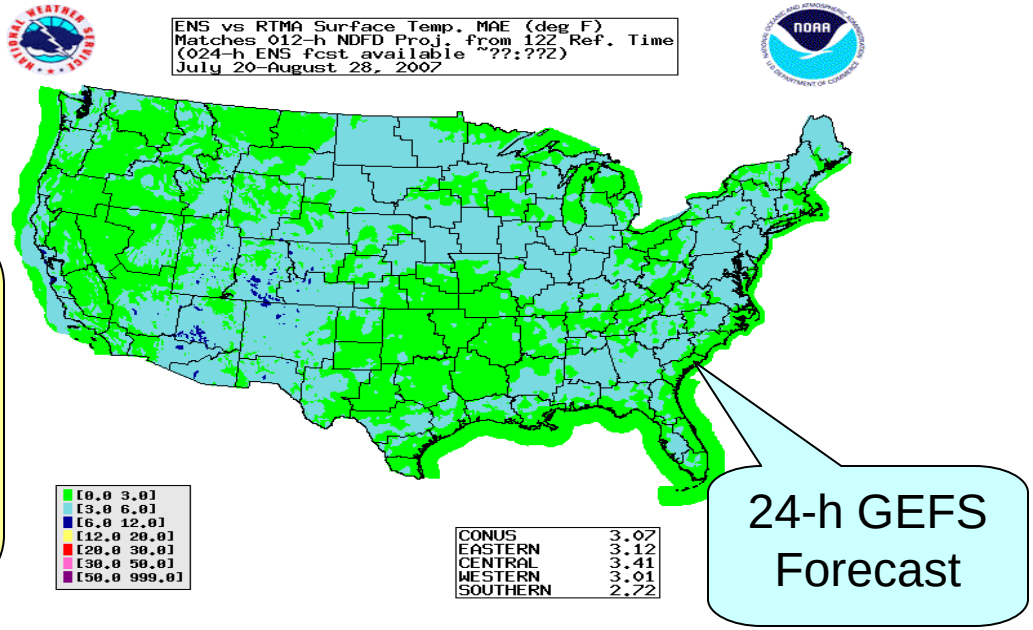
BO CUI, GCWMB/EMC/NCEP/NOAA



12-h NDFD Forecast



24-h GMOS Forecast



24-h GEFS Forecast

For CONUS GEFS beat NDFD and GMOS:

GEFS(3.07) : NDFD(3.60)

GEFS (+17%)

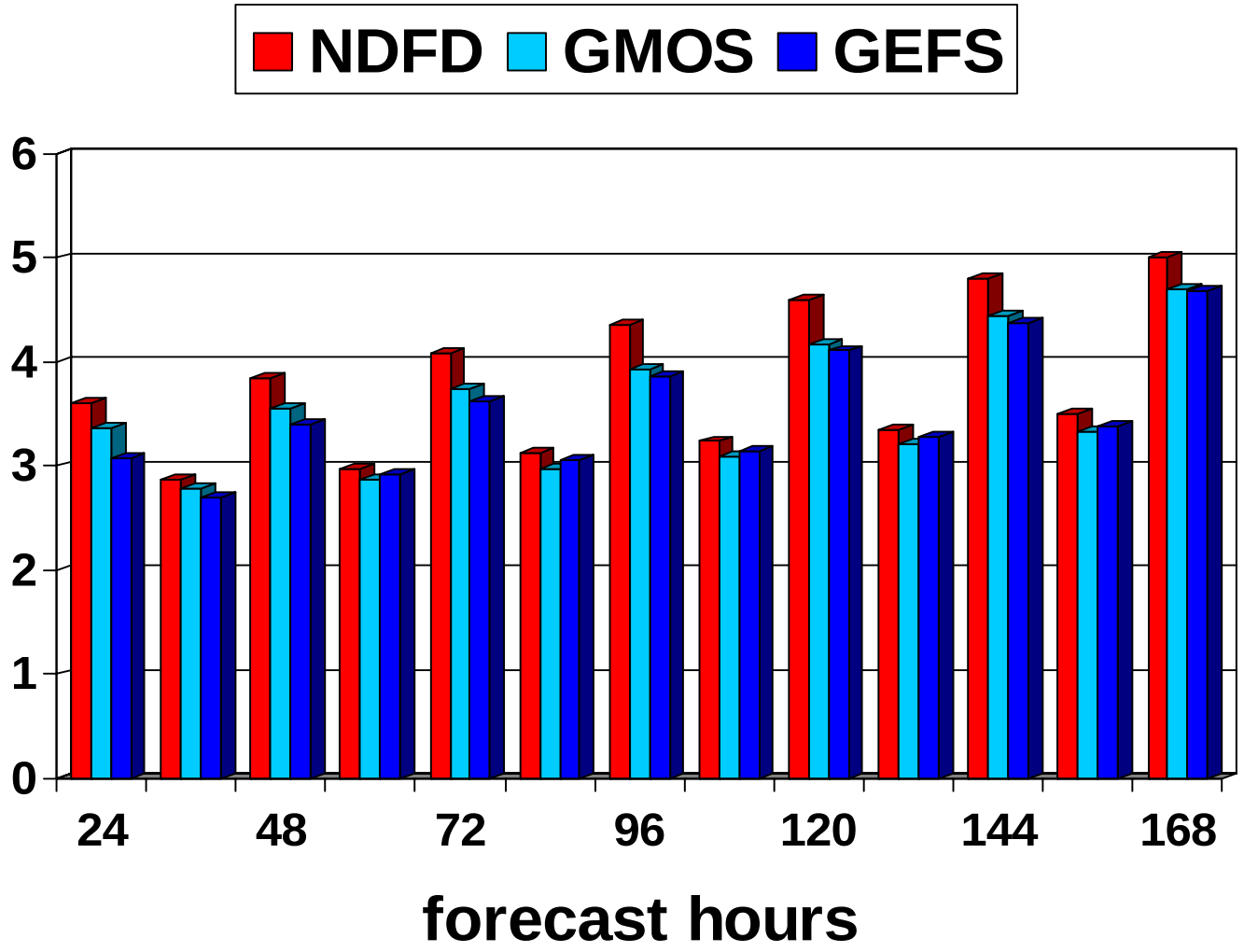
GEFS(3.07) : GMOS(3.37)

GEFS (+10%)

40 day average absolute errors of 2-meter temperature (NDFD has 12hr advantage)

CONUS only – verified against RTMA

2-m temp. forecast errors



REVIEW

- **We bias correct the data to**
  - Leverage verification and model performance knowledge
  - Extend range and skill a bit.

- **We bias correct the data to**
  - Get rid of systematic errors at each forecast time step

- **NCEP bias correction variables**
  - **They have a great set and it might grow**
  - **Only to 120 hours at this time**

- **Examples of bias corrected data**
  - **Showed a growing impact with time**
  - **Showed different impacts on different levels**
  - **High impact potential on derived variables.**